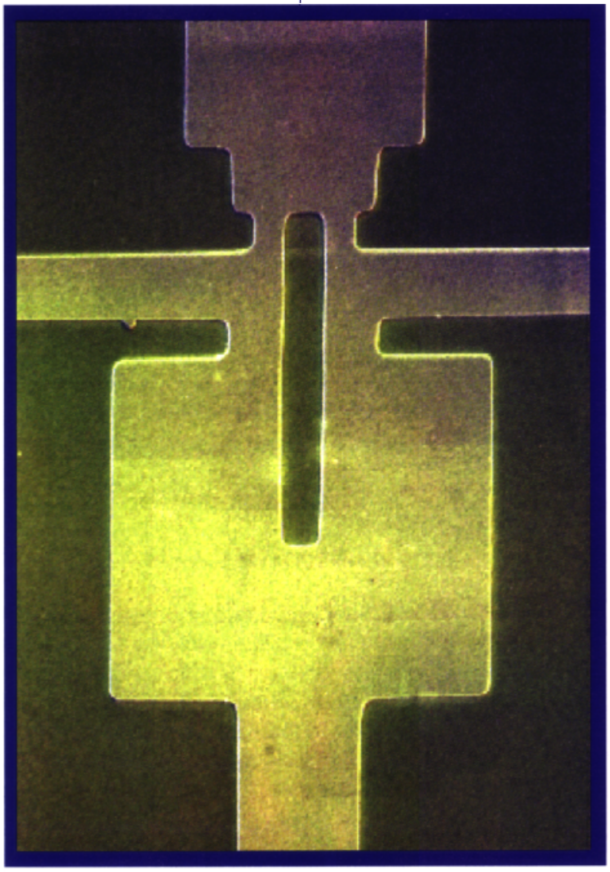
Superconductors

advancing the revolution

Superconductors have the ability to carry electric currents with little or no loss of power. This makes them ideal candidates for use in an expansive arena of applications such as ultrasensitive sensors and massive cables for electric power transmission. BES researchers have a long history in the search for improved superconductors that can be manufactured in forms useful to industry.

For example, superconducting wires power the magnets used in the magnetic resonance imaging machines that create refined images of the human body. BES researchers perfected a method for making wires of a high-performance superconductor that can generate strong magnetic fields while simultaneously remaining ductile enough to be easily formed into cables and other desired shapes. Currently, all U.S. manufacturers of this alloy use the BES-developed process.

The primary drawback for traditional, metallic superconductors is the requirement that they be refrigerated to ultralow temperatures (near absolute zero). In 1987, a superconductor revolution began with the completely unexpected discovery of an entirely new family of ceramic superconductors that required much less cooling. Since then, BES researchers have frequently been at the forefront of attempts to expand the family of superconductors and to further enhance their performance.



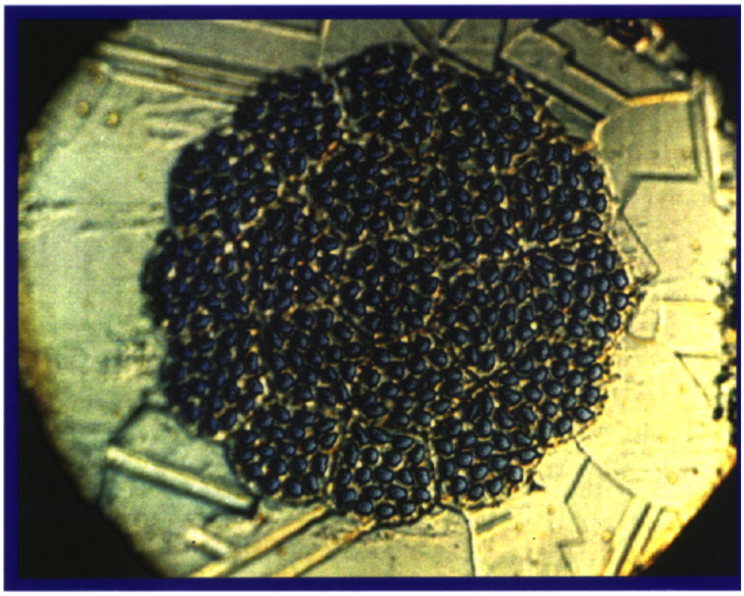
In collaboration with Lawrence Berkeley National Laboratory, Conductus, Inc., plans to market the first practical application of the new high-temperature superconductors. The device is a magnetometer capable of measuring minute magnetic fields such as those emanating from the human heart and brain. The SQUID can also be used for nondestructive evaluation of materials for hidden flaws.

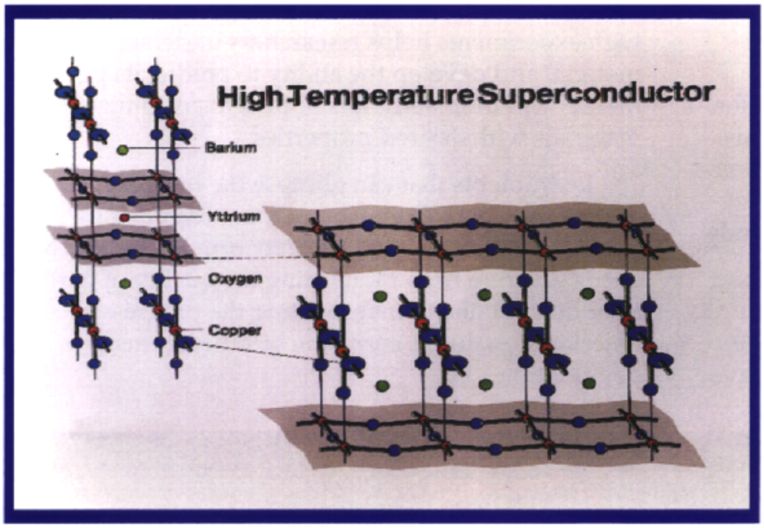
Because they are ceramics, the high-temperature superconductors are more brittle and harder to form than their metallic predecessors. Nonetheless, BES scientists are successfully working with their industrial counterparts to find innovative processes for manufacturing ductile wires, such as composite structures comprising strands of the superconductor embedded in malleable metal sheaths.

BES research has also hastened the introduction of the first high-temperature superconductor products. For example, an apparatus with the jaw-breaking name, “superconducting quantum interference device” — SQUID for short-can sense the minute magnetic fields that emanate from the human brain and heart, making it a candidate for use in demanding applications, such as non-invasive medical diagnoses.

Niobium Tin Wires

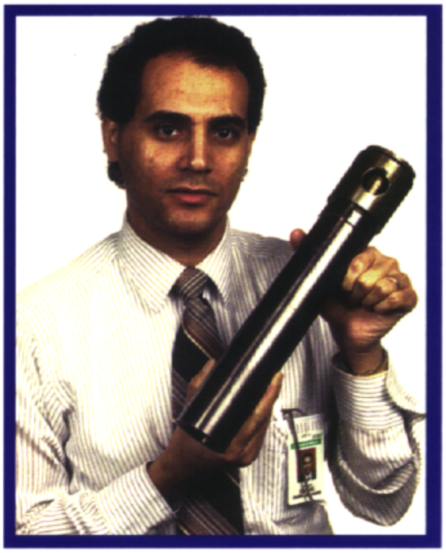
Researchers at Brookhaven National Laboratory developed an innovative method for making niobium-tin superconducting wire, which powers high-field magnets. This processing method is currently used by all U.S. manufacturers of this material. The wires consist of tiny fibers of superconductor (blue in the photo) imbedded in a copper alloy (bronze) matrix.





Superconductor Structures

Neutron diffraction has proven to be a valuable technique for studying the atomic structure of high-temperature superconductors. This was demonstrated by scientists at Argonne National Laboratory's Intense Pulsed Neutron Source, who determined the structure shown here. Argonne is working with companies like DuPont and General Electric to understand how the materials work and how to make them better.



Superconducting Filaments

Collaboration between Ames Laboratory and Babcock and Wilcox has led to a patent for a nozzle apparatus for making filaments of a high-temperature superconducting composite material that is ductile enough to use for wire conductors. Filaments of the superconductor are coated with silver, woven into yarn (shown on the right), compressed into a tape, and reacted at high temperature to form the composite.